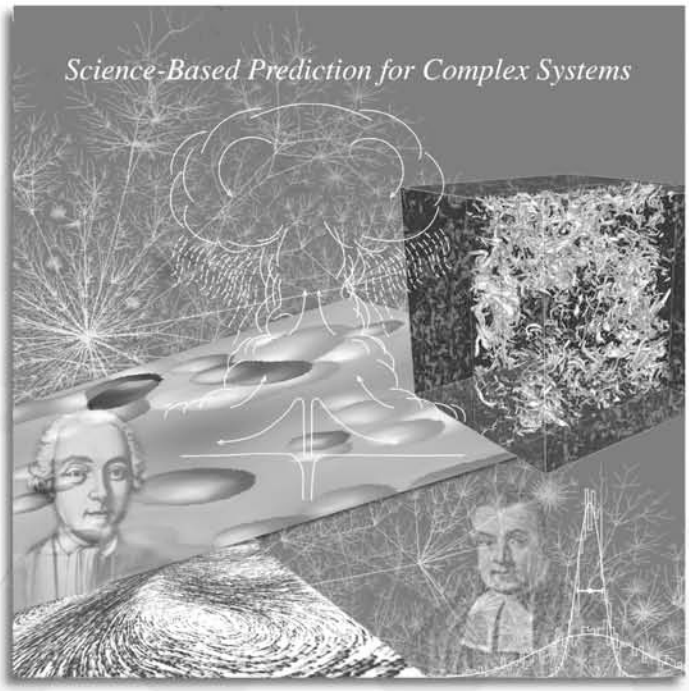

On the Cover

Complex systems come in many forms. Those on the cover were imaged through observation and computer simulation. The scale-free network filling the background shows the connections on the Internet at an instant in time. The partially ionized atoms (pink spheres) in a blue sea of free electrons (left and center) represent a quantum molecular dynamics simulation of the "warm" dense matter found in giant planets. The periodic box containing the cascading swirls of decaying turbulence (middle right) shows results from one of the largest simulations ever completed on the Los Alamos Advanced Simulation and Computing Q supercomputer. A single black-and-white swirl (bottom left) in turbulent flow shows velocity data acquired with high-power pulsed lasers and computer-automated data acquisition systems. Finally, an artist's drawing suggests the power and shape of a huge volcanic eruption (center), not unlike those of a nuclear explosion.

Attempts to predict the behaviors of such diverse systems rest not just on the power of modern supercomputers, but also on the inventiveness of the human mind and the edifice of mathematical and physical principles developed over centuries. Representative for this volume is the prolific mathematician Leonhard Euler (1707–1783), pictured at lower left. Euler wrote down the first fluid equations of motion and invented the field of graph (or network) theory. Across from Euler is Reverend Thomas Bayes (1702–1761), who was the first to use probability for inductive reasoning. Bayes' theorem for conditional probabilities (actually written down in present-day form by P. S. de Laplace) lays out the fundamental rule of statistical inference for determining the most likely behavior of complex, many-component systems. Bayesian analysis was used to reach a dramatic reduction in uncertainty for predicting nuclear fission-related processes, as illustrated by the new and old probability curves (sharply peaked and broad, respectively, in the lower right corner) for the nuclear criticality of Jezebel, a Los Alamos nuclear assembly for integral experiments.